A laboratory micro-CT setup for fast continuous scanning: applications for pore scale fluid flow research

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The migration of fluids through a porous material and the influence of those fluids migration processes on the porous material itself are crucial in numerous geological and engineering applications. In order to obtain a better understanding of the dynamics of these processes, a fast time-resolved 3D characterization of the pore space is required. In recent years, fast micro-CT imaging with sub-second temporal resolution has become available at synchrotron facilities. In laboratory based micro-CT imaging however the temporal resolution is often bound due to the limited X-ray flux. At the Centre for X-ray Tomography of the Ghent University (UGCT) a gantry-based micro-CT system (environmental micro-CT; EMCT) was developed in cooperation with XRE (www.xre.be) (Dierick et al., 2014). This setup allows a continuous acquisition with a spatial resolutions below 10 µm and a temporal resolution of 12s for a complete 360° scan. The EMCT setup is quite different compared to more common micro-CT setups as the X-ray tube and detector rotate in a horizontal plane around the sample which remain stationary. This setup is ideal to image fast dynamic processes using peripheral equipment such as a cooling stage, fluid flow cell, pressure cell, … in a top-bottom geometry.

Here we present the first results of fast dynamic imaging using the EMCT scanner and a specially designed flow cell to visualize single and multiphase flow in porous rocks. In the single phase flow experiment, advection and diffusion of a tracer salt in a water saturated limestone sample was monitored during fluid injection (animation: http://youtu.be/LfvL2-AUIrE). This illustrates the presence of preferential flow paths in the limestone which were dominated by advection and less connected pore bodies dominated by diffusion. In the multiphase flow experiment oil was injected in a brine saturated sandstone, which allow to visualize the pore scale displacement of water by oil in discrete drainage events (animation: http://youtu.be/H3Zf4xfUSbw). These first results illustrate the potential of this setup for fast dynamic micro-CT imaging in a laboratory environment.

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References

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